THE ORIGIN OF INSECTS

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The presence of a caudal stule in only the most primitive Recent insects is considered to indicate that the ancestral insect was an actively swimming (aquatic) arthropod and, if this was so, it would have had at least the abdominal appendages modified for swimming. An aquatic ancestry is supported by the presence of musculated abdominal swimming paddles representing reduced appendages, comparable with the abdominal styles of apterygote insects, in *Ephemeroptera.*

The insect body consist of a head that incorporates three past-oral segments, 12 trunk segments and an unsegmented posterior region (telson, caudal style, 10th abdominal segment).

In a terrestrial arthropod that develops a hexapod condition, appendages are reduced and finally lost from the abdomen so, even if a gill branch had been present on these appendages of the ancestor of the insects it is most probable that is would have been lost from all appendages during the development of the insect body form.

The primitive aquatic insect could have had a body form resembling that of the Cambrian *Emeraldella* (*Trilobitomorpha*). *Emeraldella* had a head that probably incorporated three postoral segments, a trunk of 12 segments of which the anterior ten segments had well developed pleural lobes whereas the caudal two had very reduced pleural regions, and the body ended in a long caudal style.

The appendages of *Emeraldella* were apparently all of the generalized trilobite form. When differentiation of the appendages into mouth parts, walking legs and swimming appendages was accomplished, the arthropod would become a primitive swimming insect. It is considered to have had a form resembling that of a siphlonurine mayfly nymph, except possibly for pleural lobes on the anterior abdominal segments, no lateral cerci, and non-labiate mouth parts.

Pleural lobes on the abdominal segments of the primitive insect would be reduced to allow greater movement of the abdominal appendages as the insect became more adapted for swimming. The pleural lobes (paranotal processess) remained, however, on all three thoracic segments where they would act as stabilizers during swimming. Thus, the pleural lobes of the thorax had an important function on the primitive, apterygote, aquatic insect. The posterior two pairs simply changed their function to develop into the wings of pterygote insects.

It is postulated that the original aquatic insect spent the whole of their life in water. If this was so, they would not develop labiate mouth parts nor would they possess a tracheal system. In those insects that left the water for part of their life, it is natural that, when tracheae developed, branches should penetrate into the abdominal appendages (swimming paddles) of the immature aquatic stages.

In siphlonurine and other mayfly nymphs (*Ephemeroptera*) the basal fibrillar tuft of the abdominal swimming paddles («gills») are apparently the major functional respiratory structures. They can be compared with the basal gill branch of the trilobite appendage except that they are almost invariably inserted below, instead of above, the appendage.

All Recent *Paleoptera*, generally regarded as amongst the most primitive insects, have aquatic nymphs. Those orders of *Neoptera* in which all, or the great majority of Recent species have aquatic immature stages are usually regarded as the most primitive orders or as a primitive order within a group of related orders. The more primitive members of each of the aquatic orders spend the longest periods in water. *Ephemeroptera*, one of the most primitive orders, and the only order with two winged stages, require a subimaginal stage that is only poorly adapted for flight, to change from the aquatic nymph to the fully winged stage.

The postulated ancestral insect would be dictinguished from some Paleozoic *Crustacea* and *Trilobitomorpha* only on its appendages of which are the structure of the mandible would be most significant.